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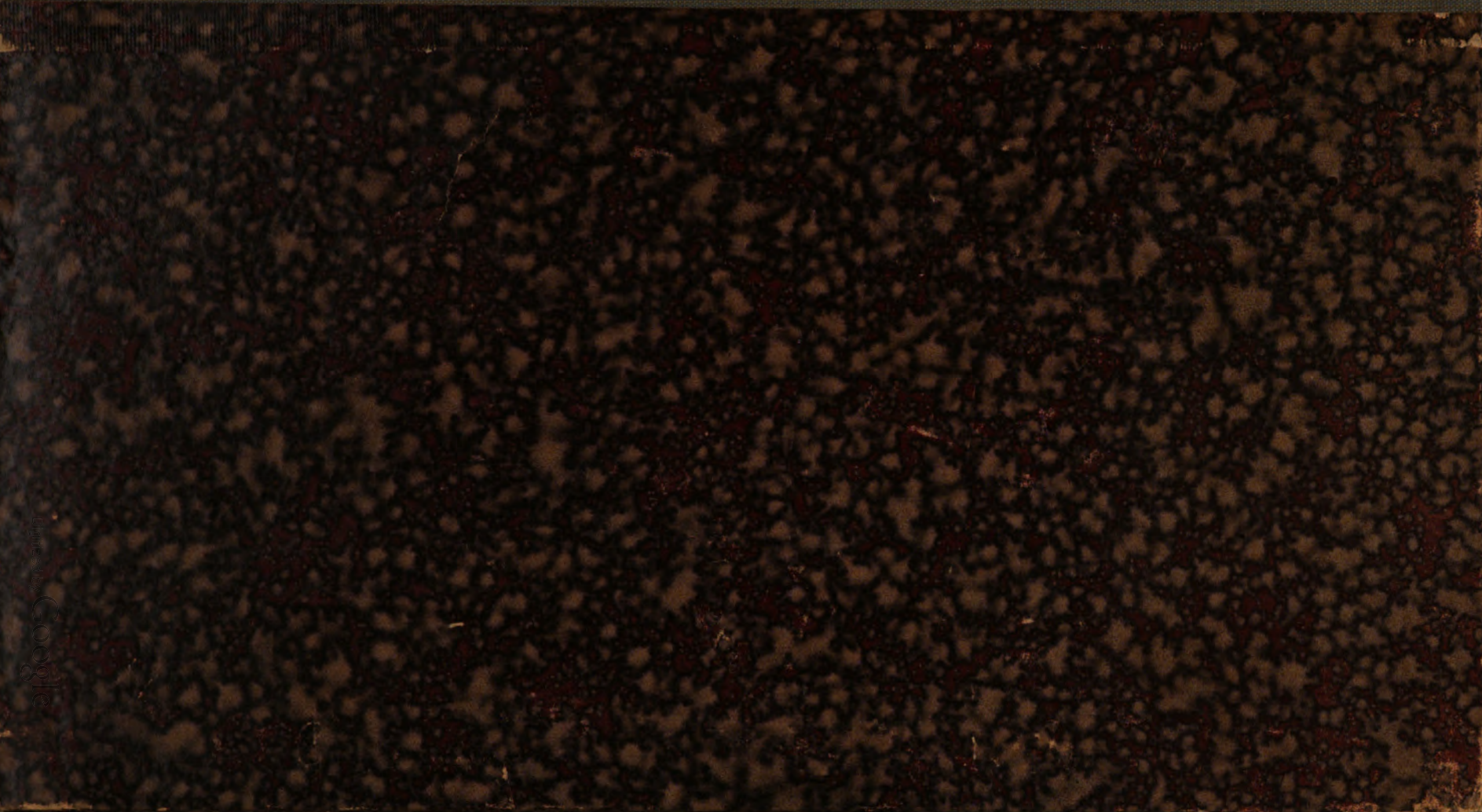

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Manus, Sacrum, and Caudals of Sauropoda.

By Henry Fairfield Osborn.

AUTHOR'S EDITION, extracted from BULLETIN
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Article XIV. — MANUS, SACRUM, AND CAUDALS OF SAUROPODA.

By Henry Fairfield Osborn.

Dinosaur Contribution No. 7.

The following notes on new materials from the Bone Cabin Quarry in the American Museum were prepared for the U. S. Geological Survey monograph on the Sauropoda, and partly correct previous papers. I am indebted to Mr. Walter Granger, who has charge of the Bone Cabin collection, for several valuable observations, and to Director Charles D. Walcott of the Survey for permission to publish in this form.

I. STRUCTURE OF THE MANUS.

My previous figures and descriptions of the manus are all incorrect.

The single Claw on Digit I. — From two specimens in the Field Columbian Museum, from the correctly described (Hatcher) and figured manus of *Brontosaurus* in the Carnegie Museum, and from eight specimens in the American Museum, it appears as if in the manus of *Diplodocus*, *Brontosaurus*, and possibly of *Morosaurus*, there was but one claw, and that a small one, on the pollex. Two specimens only in the American Museum (Nos. 276, 332) exhibit two claws, but both are of very doubtful association.

The *oblique direction* or partial *retroversion* of this pollex claw (D. I.) is a feature to which Dr. E. S. Riggs especially directed my attention; the inferior facet of Mtc. I, and the two facets of the proximal phalanx are bevelled in such a manner as to give an oblique outward and slightly backward angle to the terminal or claw phalanx; the retroversion, however, is much less marked than in the manus of the Theropoda.

Phalanges reduced. — The first phalanges on D. II–V all terminate, like the phalanges of D. IV and D. V, in the pes of some species, in non-facetted, peculiarly spread surfaces which apparently bore no second or additional phalanges.

Amphiaxonic Manus. — The manus in these two specimens

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is more properly amphiaxonic than mesaxonic (Osborn) or entaxonic (Hatcher). The five digits distribute the weight about equally.

Coalesced Carpalia 1–3. — The large element which I described as a scapho-lunar (or radiale + intermedium) has been observed by Mr. Granger to fit very closely by distinct facets on top of Mtc. I and Mtc. II, also to rest partly on Mtc.

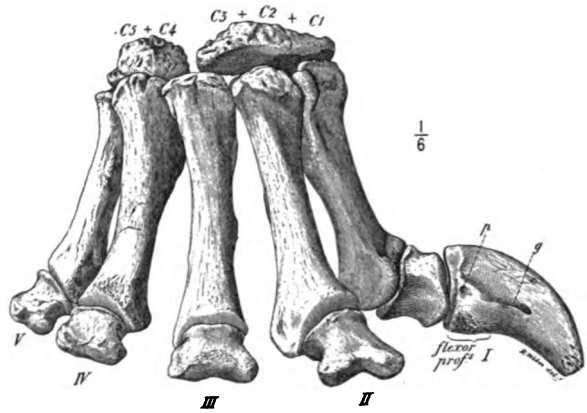

Fig. 1. Manus of *Morosaurus* sp. No. 965, Amer. Mus. ×⅛. *p*. pit; *g*, groove.

III. It therefore represents the distal carpalia 1–2 or 1–3 instead of radiale + intermedium as I supposed.

The other large element probably represents carpalia 4–5 and rests on Mtc. IV and Mtc. V.

The proximal elements of the carpus thus were cartilaginous or remain unaccounted for.

The wrist joint *appears* to have been between the radius and ulna and the distal carpalia instead of the proximal carpalia, thus presenting an analogy with the intratarsal joint of the pes. This point, however, requires confirmation.

2. SACRO-PELVIC ARCADE.

The following observations are based on three unusually complete specimens from the Bone Cabin Quarry, which in part confirm, in part disprove, and in several points amplify

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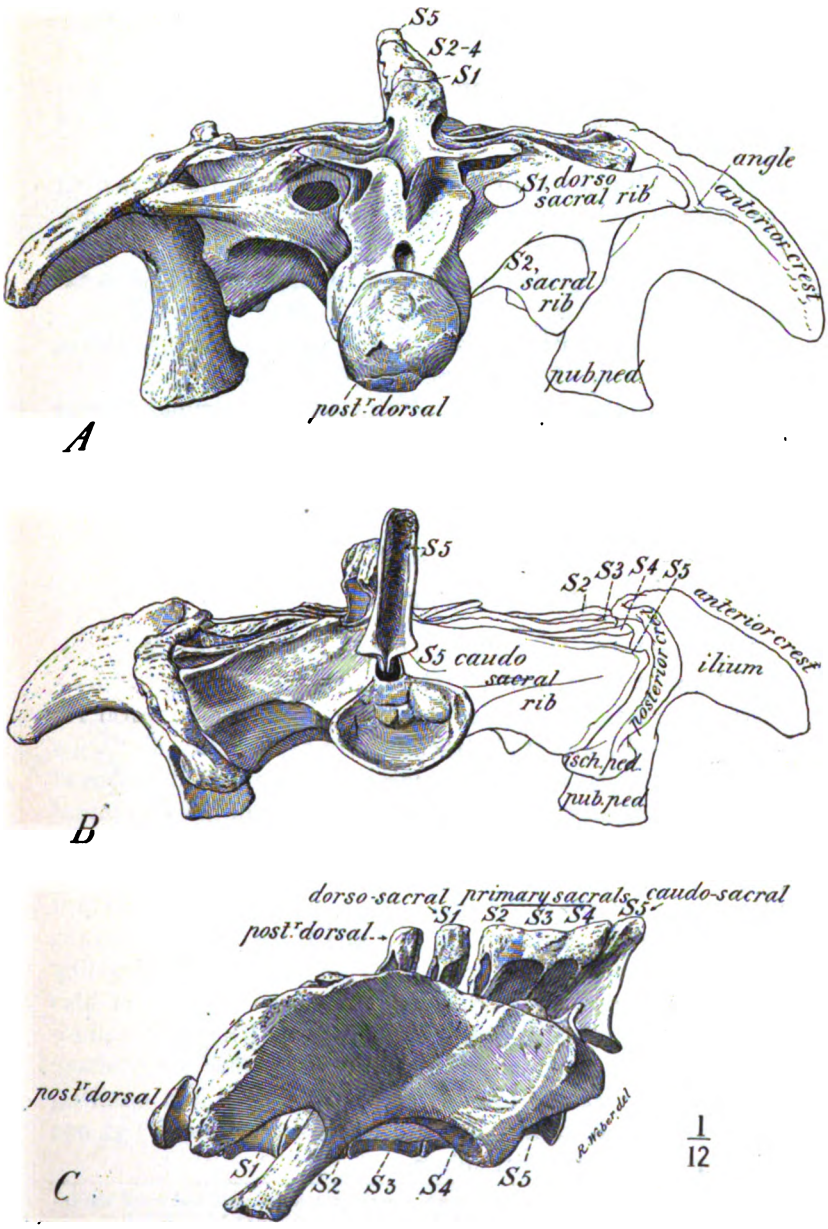

Fig. 2, *A–C*. Anterior, posterior, and left lateral views of the ilium and sacrum of *Morosaurus* sp. No. 690, Amer. Mus. × 1/12. *pub. ped.*, pubic peduncle of ilium; *isch. ped.*, ischiadic peduncle of ilium.

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previous observations by Marsh, Osborn, Williston, Hatcher, and Riggs.

In comparison with sacra already described they demonstrate the existence of several forms of sacral structure in the Sauropoda.

The vertebral and rib + diapophysial elements composing the sacrum in these three specimens may be clearly distinguished as follows:

I. One or two dorso-sacrals, more or less modified, with expanded dorsal ribs.

II. Three primary sacrals, with large, expanded sacral ribs.

III. Caudo-sacral with a modified caudal rib.

The key to the position of the single-headed primary sacral and caudal ribs is found in the Protorosauria (*Palæohatteria*, *Protorosaurus*), the probable ancestors of the Dinosaurs, in which these ribs spring low down from opposite the centra.[1]

Morosaurus.

(Fig. 2, *A–C*, Fig. 2, *D*, *E*.)

The sacral arcade of the aged individual (Amer. Mus. No. 690) is built up of five vertebræ as follows: *S. 1*, a dorso-sacral, or recently modified posterior dorsal; a bicipital rib (Fig. 2, *A*) with elevated attachment of capitulum; rib flaring distally, to unite with antero-internal angle of inner face of ilium, forming part of the posterior boundary of the abdominal cavity, ascending to the superior border, and sending off an inferior branch to unite with the outer portion of the first primary sacral rib and pubic peduncle of the ilium, but not entering the sacral plate. *S. 2–4*, the three primary sacrals, with closely coalesced neural spines (Fig. 2, *C*) and expanding rib plates and diapophyses, all entering sacral plate, also forming portion of the acetabulum (Fig. 2, *D*). *S. 5*, caudo-sacral with neural spine coalesced at base with the primary sacral neural spines, broadly expanding rib plate entering back portion of sacral plate and ischiadic peduncle, but not forming portion of acetabulum.

[1] The Reptilian Subclasses Diapsida and Synapsida and the early history of the Diaptosauria. Mem. Amer. Mus. Nat. Hist., Vol. I, Pt. viii, Nov., 1903, p. 502.

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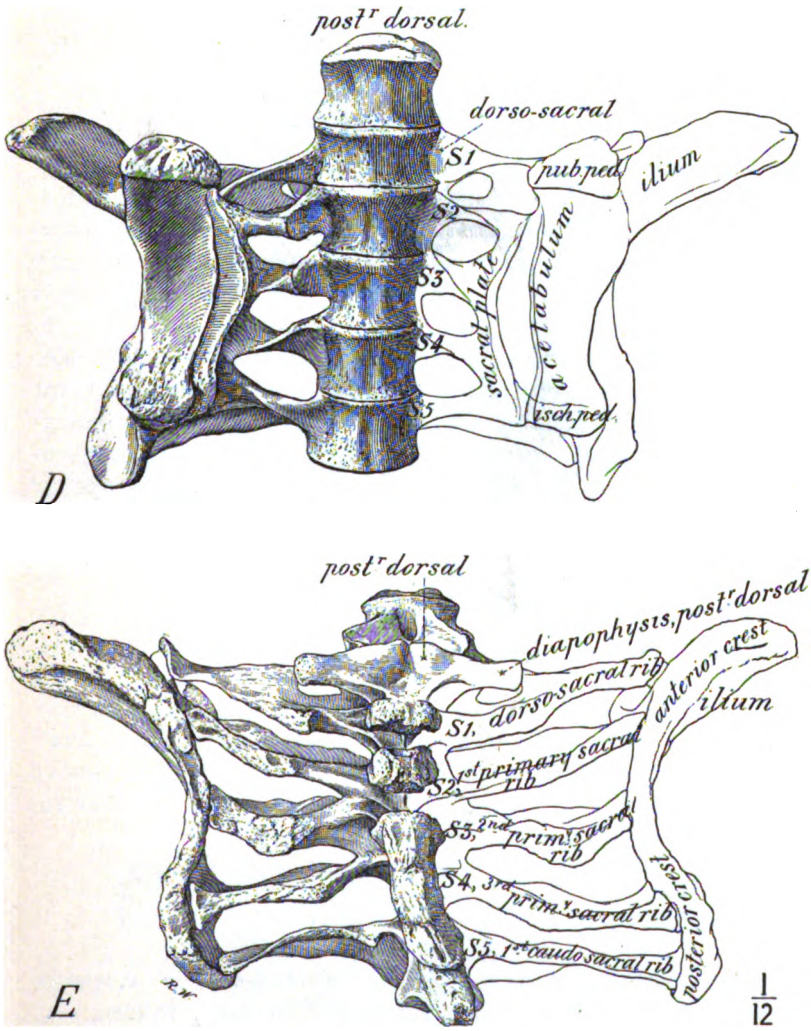

Fig. 2, *D*, *E*. Inferior and superior view of same specimen. (See Fig. 2, *A*–*C*.)

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This proves that *Morosaurus*, including the dorso-sacral, has five sacral vertebræ, the centra of which diminish in size from first to last, unlike those of *Diplodocus* and *Brontosaurus*.

Diplodocus.

(Fig. 3, *A–B*.)

The morphology of the sacral arcade is still more perfectly shown in a young *Diplodocus* (Amer. Mus. No. 516) in which all the dorsals, sacrals, and anterior caudals were found interlocked, leaving no question as to the enumeration. The 10th or posterior dorsal vertebra shows its capitular attachment of the rib opposite the pleurocœle.

S. 1, the 11th dorsal or first dorso-sacral, exhibits a slender rib plate (*r. 1*), capitulum rising opposite pleurocœle at a point slightly lower than in the true dorsal, diapophysial lamina expanding laterally to unite with the angle on the antero-internal face of the ilium, which constitutes the posterior boundary of the abdomen; this rib sends off a small independent spur to the pubic peduncle, but does not unite with the sacral plate proper. *S. 2–4*, three primary sacrals; first and second primary sacrals (*S. 2–3*) with short centra, large ribs attached below pleurocœle on sides of centra, expanding dorsally into rib plates confluent with the diapophysial laminæ; third primary sacral (*S. 4*) with very long centrum, sacral rib (*r. 4*) attached above pleurocœle as in caudo-sacral. *S. 5*, caudo-sacral, with heavy sacral rib attached above pleurocœle uniting distally with posterior border of sacral plate and posterior crest of ilium.

Brontosaurus.

(Fig. 4, *A*, *B*, *C*.)

The sacrum and pelvis (Amer. Mus. No. 675) is exceptionally complete; it exhibits six sacrals disposed as follows:

S. 2, a posterior dorsal (probably dorsal No. 10), or first dorso-sacral; spine and centrum elevated, bicipital rib with shaft flaring laterally and broadly uniting with the angulate antero-internal face of the ilium (Fig. 4, *A*); a narrow in-

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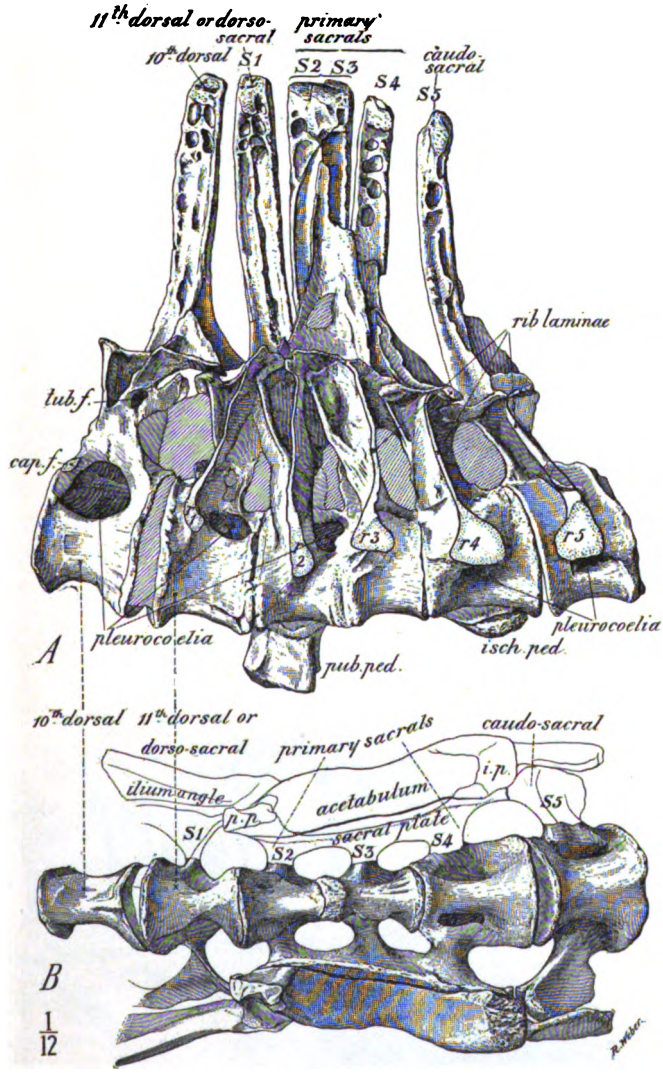

Fig. 3, *A–B*. Sacrum of *Diplodocus longus*. Left lateral and inferior views. No. 516, Amer. Mus. × 1/12.

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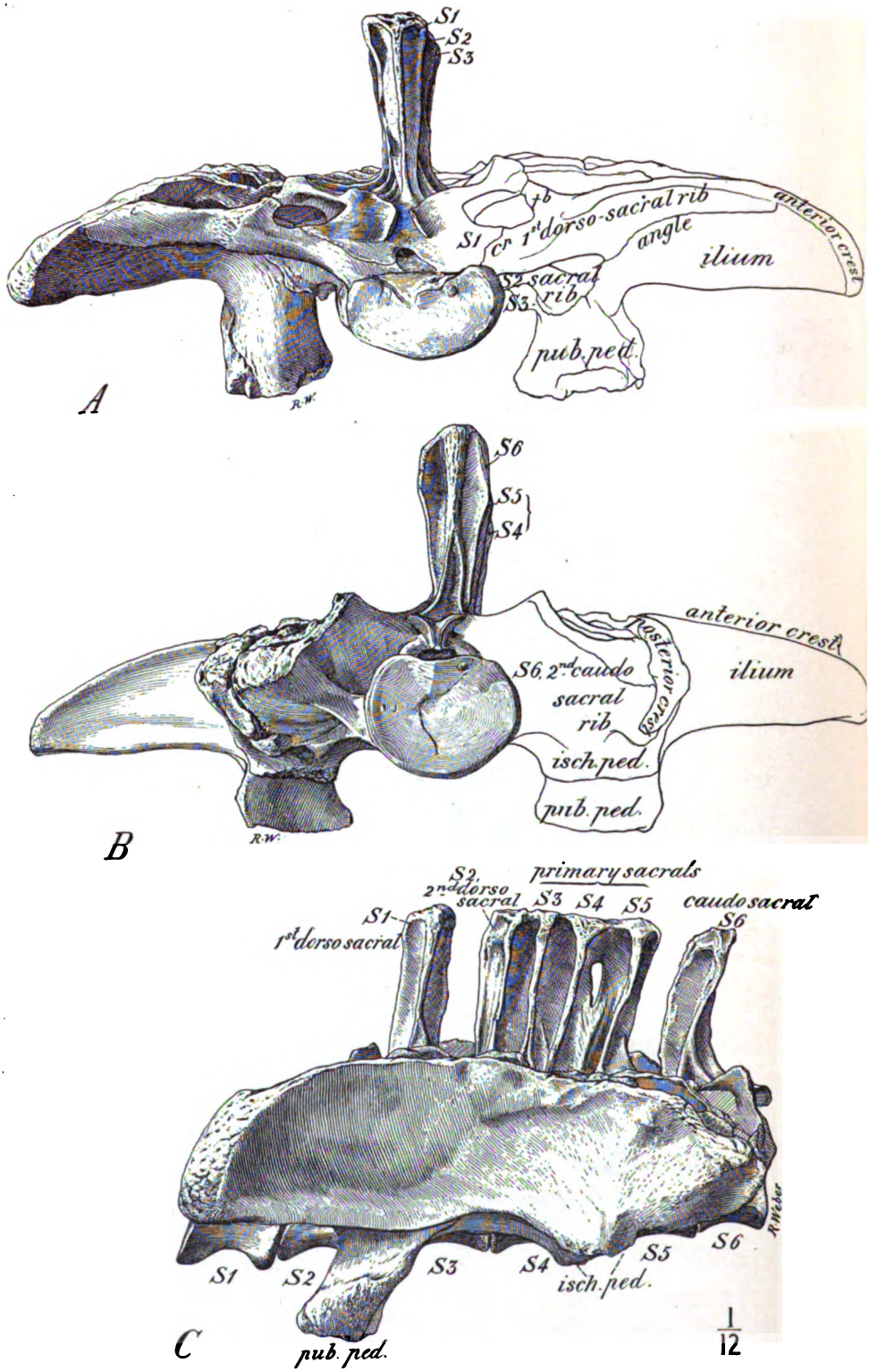

Fig. 4, *A*, *B*, *C*. Anterior, posterior, and left lateral views of the sacrum and ilium of *Brontosaurus* sp. No. 675, Amer. Mus. × 1/12.

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ferior spur to rib of *S. 2*. *S. 2*, second dorso-sacral, spine and centrum coalesced with those of first primary sacral; relatively narrow rib uniting laterally with peduncle of ilium and anterior border of sacral plate, rising above to crest of ilium in a thin diapophysial plate. *S. 3–5*, three primary sacrals constituting main portion of sacral plate with coalesced neural spines, ribs expanding into diapophysial plates above; *S. 3* with broad sacral rib entering sacral plate and acetabulum; *S. 4* with a short centrum and narrower sacral rib sharply ridged below, also entering acetabulum; *S. 5*, unusually long centrum with broad rib (which does not enter acetabulum) uniting with ischiadic peduncle. *S. 6*, caudo-sacral, with a broad sacral rib uniting with posterior portion of sacral plate and ischiadic peduncle, with diapophysial plate uniting with posterior crest of ilium.

The inferior view of these vertebræ corresponds in character with Marsh's figures of *Brontosaurus excelsus* and of *B. amplus*.

These descriptions and figures bring out very clearly the fundamental resemblances and differences between the sacra of *Morosaurus*, the simplest type, *Diplodocus*, an intermediate type, and *Brontosaurus*, the most specialized type.

3. COALESCENCE OF CAUDALS.

(Fig. 5.)

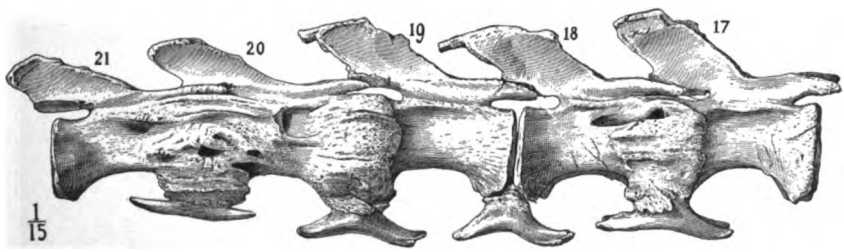

Fig. 5. Caudals 17–21, right side of *Diplodocus longus*. No. 655, Amer. Mus. × 1/15.

As observed by Osborn and Hatcher in *Diplodocus*, the chevrons and centra of the caudals between 16 and 18 tend to coalesce, indicating apparently a fixed or resting point in the tail. In the large individual (No. 655, Amer. Mus.) caudals

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Nos. 17 (?), 18 (?), and 19–21 (?) are coalesced with each other and with their respective chevrons; there is also more or less lateral exostosis at the joints.

No indication of such coalescence is thus far recorded in the caudals of *Brontosaurus* and *Morosaurus*. A specimen of the

Fig. 6. Caudals 14 (?)–20 (?) of *Brontosaurus* sp. No. 222, Amer. Mus. ×1/15.

tail of *Brontosaurus* in the same region is interesting as showing the freedom of the short vertebræ and the grooves on the neural spines and centra caused by the teeth of carnivorous dinosaurs.

4. SMALL TERMINAL CAUDALS.

Small terminal caudals have already been described by Osborn in *Diplodocus*. A specimen of *Brontosaurus* shows that the tail terminates in at least five rod-like caudals.

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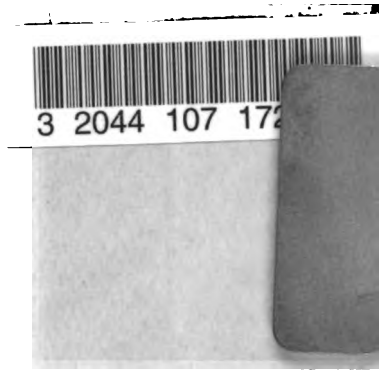
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